A DISSERTATION ON

A STUDY OF ANTERIOR DECOMPRESSION AND INSTRUMENTATION IN TUBERCULOSIS OF SPINE

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Certificate

This is to certify that this dissertation entitled **"A STUDY OF ANTERIOR DECOMPRESSION AND INSTRUMENTATION IN TUBERCULOSIS OF SPINE"** *submitted by* ***Dr.* R. PRABHAKAR** *appearing for Part-II M.S. Branch-II Orthopaedic Surgery Degree examination in September 2006 is a bonafide record of work done by him under my direct guidance and supervision in partial fulfillment of regulations of the Tamil Nadu Dr. M.G.R. Medical University, Chennai.*

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CONTENTS

INTRODUCTION

In April 1993, World Health Organization (WHO) has declared Tuberculosis as a global emergency because it was out of control in many parts of the world. More than 3.8 million new cases of all forms of tuberculosis, 90% of them from developing countries, were reported to the WHO in 2001. However, because of low level of case detection and incomplete notification, reported cases represent only the tip of the iceberg and it is estimated that 8.5 million new cases of tuberculosis occurred Worldwide in 2001, 95% of them in developing countries. It is also estimated that 1.8 million deaths from tuberculosis occurred in 2000, 98% of them in developing countries.

In India approximately 10 million cases of tuberculosis exists. 1-3% of the 10 million have involvement of bone and joints. The commonest skeletal lesion is the vertebral lesion which is responsible for 50% of all bone and joint tuberculosis. The estimated number of spinal tuberculosis cases in India is between 30,000 and 90,000 cases.

Skeletal tuberculosis constitutes 1-3% of tuberculosis affections of the human body and spinal tuberculosis accounts for 50% of skeletal tuberculosis. It is a preventable disease to some extent and totally curable if treatment is started in early stage. For successful management of tuberculosis, the patient and his family should understand the importance of early recognition of the disease and adherence to the presented regimen of antitubercular treatment.

The advent of modern day multi drug chemotherapy for tuberculosis has drastically changed the management and the results of the disease today. But spinal tuberculosis is a unique entity in that the late complications can have devastating effects because of proximity to the cord. Ambulant chemotherapy could eradicate the disease completely, but could not prevent the development of kyphotic deformity or the neurological deficit precipitated by cord compression. Earliest method of treatment was to keep the patient in bed with cast or ambulation with braces. But this form of treatment could only prevent the deformity to a very small extent.

The commonly used method of placing anterior strut grafts in the defect created by excision of the infected vertebral bodies corrects the kyphotic deformity, but the grafts are prone to failure or resorption especially when more than two vertebrae have been excised.

Instrumentation for tuberculosis began as a correction of deformities following eradication of disease and was later used even during active disease to prevent deformity. Oga et al[8] study confirms that the biofilm formation of tuberculous bacilli is not very prominent, so that penetration of Antituberculosis drug is effective in skeletal tuberculosis. Based on this study posterior instrumentation is used to protect the graft, stabilize the segments, and prevent progression of deformity. The idea behind the posterior instrumentation was that it was away from the infective focus.

Anterior instrumentation, which are very close to the infective focus has been used in case of moderate to severe kyphotic deformity in skeletal tuberculosis of dorsal and lumbar region and found to be very useful by several authors.

AIM OF THE STUDY

To assess the results of anterior decompression and anterior instrumentation in patients with dorsal and lumbar caries spine with kyphotic deformity and neurological deficit.

HISTORICAL BACKGROUND

The tubercle bacillus has co-existed with Homo sapiens since time immemorial. The Rig Veda, Atharva Veda (3000-1800 BC) and Samhita of Charaka & Sushruta (1000 & 600BC) recognized the disease as “Yakshme” in humans, which by its symptoms and signs could only be tuberculosis of the lungs. Tuberculous lesions have been found in Egyptian mummies and the Greco Roman civilization recognized phthisis or consumption as a problem of the lungs.

Laennec (1781-1826), described in the beginning of nineteenth century, the basic microscopic lesion, the ‘tubercle’ the name by which the disease is universally known at present.

Tuberculosis of the spinal column was first described by Percival Pott in 1779. The classical destructive lesion of the disc space and the adjacent vertebral bodies, collapse of the spinal elements and severe and progressive kyphosis subsequently became known as Pott’s disease.

BACTERIOLOGY

Tubercle bacilli are mainly of two types; human & bone. According to Western reports, bovine tubercle bacilli are responsible for 80% of osteo-articular lesions below the age of 10 years.

The human bacillus is responsible for almost all cases of osteoarticular tuberculosis in India. Bacteriological confirmation by identification of the bacillus in cold abscess aspirate or biopsy taken from the site of the lesion or culture of bacilli in Lowenstein Jenson medium would be necessary in certain cases. In the Indian Scenario, various studies have shown varying rates of confirmation. 40-80% by Dahl, 70.8% by Tuli, and 87% by Lakhanpal after culture and guinea pig inoculation[11].

Dobson et al have confirmed Dahl's findings of 1951 and 1973[11]. Atypical myobacthsia, other than M. Tuberculosis tumanis or bones have been reported in lesions of the syrovial sheath. The transmission of atypical mycobacteria can not be by contact. The following factors would have to be considered in this regard: (1) Trauma (2) Local steroid injection (3) Surgical trauma (4) Diabetic status (5) use of chemical immuno suppressive drugs like cydosporin in organ transplantation and (6) Acquired immunodeficiency syndrome.

CLINICAL ASPECTS OF SPINAL TUBERCULOSIS

The commonest skeletal lesion in the vertebral lesion which is responsible for 50% of all bone and joint tuberculosis.

The commonest age of occurrence is the first three decades of life but it can occur at any age and has been reported from the first year of life to among those 80 years old. The disease occurs most frequently in both the sexes. In most cases, the lesion is insidious in onset and only rarely is there an acute manifestation. The most common general symptoms are weight loss, lassitude and evening rise of temperature. Locally, there is stiffness, painful restricted joint movements in all the planes and severe spasm of the surrounding muscles. If the lesion has been present for a sufficiently long time, a cold abscess occurs in the soft tissues, tracking its way through the inter muscular planes. A deformity, in the spine can be present as kyphosis along with local tenderness and proximal lymphadenopathy.

Tuberculosis of the spine can occur

1. Usually secondary to tuberculosis elsewhere by haemotogenus or lymphatic spread, most commonly through Batson's prevertebral venous plexus.

2. By contiguous extension from a pulmonary abscess, commonly leading to thoracic spondylitis.

3. As primary infection. This is being increasingly reported, possibly by ingested bacteria reaching here by haematogenous route from gastro-intestinal tract.

Tuberculosis of the spine has the following distribution: thoracic - 42%, thoraco-lumbar - 12%, Lumbar - 26%, Cervical - 12%, Cervico dorsal - 5%, and Lumbo - Sacral - 3%.

Lesions in the spine is often classified into the following varieties, according to radiological involvement

1. Paradiscal: This is the commonest variety and involves the adjacent margins of two consecutive vertebrae. The intervening disc space is reduced and the vertebral margins appear fuzzy. The infection is believed to be via the arterial blood supply, which is segmental and follows embryonic pattern that supplies inferior half of superior vertebra and superior half of inferior vertebra.

2. Central: This involves the central portion of a single vertebra, keeping the proximal and distal disc spaces intact. The possible lodgment of the infection comes via the venous route in this variety.

3. Anterior marginal; The lesion begins as a destructive lesion in one of the body of a vertebra, minimally involving the disc space but not involving past of the vertebra on either sides.

4. Posterior: The disease localizes itself in the posterior element i.e., the lamina, pedicle or the spinous process. The infection is said to be coming via the arterial supply to these structures. There is no involvement of the body of the vertebra. This variety many a times may present primarily as neural deficit without any lesion in the body. The clinical differentiation comes by the presence of an acute

posterior midline spinal tenderness over the involved vertebra much more than vertebral body lesion.

5. Synovial: The disease involves synovium of atlanto-axial and atlanto-occipital joints.

The clinical presentation of spinal tuberculosis is extremely protean. The type and severity of symptoms vary depending on the level of involvement, the severity of the disease and the duration of the infection. Patient usually present with combination of constitutional manifestation such as weight loss, fever, fatigue and malaise, a well as focal pain. Most of the patients present with relatively moderate and chronic symptoms despite severe vertebral destruction. The pain varies from mild and constant to severe and activity related. Pain is typically localized to the site of involvement and is most common in the thoracic spine. It can be constant and indolent, reflecting the progressive destruction of the involved disc space and vertebral elements, or it can be intake and directly linked to spinal motion, coughing and weight bearing, which is caused by more advanced disc disruption and spinal instability, nerve root compression, or pathological fracture.

Patients may present with cold abscess tracking out. Since the cold abscess is the most common and important finding for establishing the diagnosis of tuberculosis of the spine, the anatomical path of the cold abscess is of great importance. In any region, prevertebral accumulation of pus is a very noticeable feature.

In the cervical spine, it present as a retropharyngeal a preverbal shadow, but could also be anatomically located in the following sites: 1) Behind the prevertebral fasica (2) along the posterior border of stemomastoid muscle (3) in the supraclavicular area and rarely (4) down the mediastinum to become an upper mediastinum mass visible on x-ray (5) in the back of the neck lateral to the posterior spinal muscles and (6) tracking down the brachial plexus to present in the axilla or even the elbow joint, along one of the main nervous of the upper extremity.

A thoracic cold abscess is quite frequently prevertebral or posterior mediastinal in location. It could, however, track along the intercostal nerves to present at the following sites:

a) Anterior end of intercostal space.

b) Abdominal wall behind the rectus sheath.

c) Midaxillary line and

d) Along the posterior division of the intercostals nerve lateral to the sacro-spinalis muscle mass.

In lower thoracic lesions, below D10, the cold abscess might take various routes. The abscess can track along

a) Behind the lateral lumbo-costal arch of the origin of the diaphragm and present in the per nephritic space or in the layers of the anterior abdominal wall.

b) Behind the medial lumbo-costal arch of the origin of the diaphragm and enter the psoas sheath and present as a psoas cold abscess, palpable above the inguinal ligament or on the medial aspect of the thigh, if it traverses below the inguinal ligament.

c) It can go behind the median arcuate ligament of the origin of the diaphragm along the aorta and its branches and can, thus have wider sites of presentation, as the lumbar cold abscess does.

A lumbar cold abscess can spread along the aorta and its branches to present at the (1) Ischiorectal fossa (2) in the buttock, under the gluteus maximus (3) along the psoas sheath or (4) in the lumbo-dorsal (Petit's) triangle. It can also track down along the femoral or obtrurator artery and present on the medial side of the thigh; femoral triangle; popliteal fossa or on the medial side of tendo achilles.

Neurological symptoms of spinal tuberculosis may be subtle, but will progress on time. Compressive myelopathy is the most common neurological manifestation of pott's spine.

The vertebral regions commonly involved in paraplegia of hematogenous origin are thoracic, thoraco-lumbar, lumbar and cauda equina in that order. The level of spinal cord involvement determines the level of impairment.

Griffith, Seddon & Roaf classified tuberculosis paraplegia in two grades.

Grade A and Grade B.

Grade A with early onset, within 2 years after onset of symptoms of tuberculosis and.

Group B: with late onset i.e., after more than 2 years. Group B paraplegia might be due to recrudescence of disease, mechanical pressure result of severe kyphosis, inadequate blood supply to the spinal cord as a result of slow exsanguinations resulting in a fibrous cord and pathy meningitis. Grade B, in general, has a poor prognosis.

Grade A paraplegia (Pott's paraplegia) have also been described as (Goel, 1967, Tuli 1985 Kumar, 1988)

Grade 1: The patient is not aware of the problem. On clinical examination, there are signs of compression, usually exhibited by long tract involvement signs or segmental paresis. The patient is able to walk.

Grade 2: There is evident spasticity but the patient is able to walk, often with jumpiness in the gait. Long term involvement signs are significantly present.

Grade 3: The patient is bedridden and has spastic paraplegia in extension with demonstrable neurological deficits, both sensory and motor.

Grade 4: Paraplegia occurs with flexor spasm. There is bladder and bowel involvement and total sensory and motor loss. The prognosis is poor.

DIAGNOSIS:

The investigations to establish the diagnosis are primarily x-ray examination and imaging technique such as computerized axial tomography (CAT) and MRI.

RADIOGRAPHIC APPEARANCE:

The paradiscal lesions shows a reduction in disc space before osseous destruction occurs, but focal osteoporosis is seen easier than disc space reduction. One of the most important diagnostic radiological criteria is the delineation and study of paravertebral shadows. In the cervical region, the normal retropharyngeal space is 1.5 cms below the cricoids cartilage any increase beyond this should make one respect the possibility of an increase in the retropharyngeal shadow. In the dorsal region, below the 4^{th} dorsal vertebra typical fusiform 'Bird Nest' abscess is commonly seen.

Specific radiological appearance in the spine may include, an aneurysmal type scalloping along the anterior margin of the vertebral body, mostly as a route of cold abscess under the anterior longitudinal ligament.

Rarely, lateral curvature of the spine (scoliosis) may be seen but the most common is kyphotic deformity i.e., increase in the antero-posterior curvature.

CT scan in spinal tuberculosis has its value in detecting the lesion in areas otherwise difficult to be seen on x-rays like posterior arch, cranio vertebral, cervicodorsal, lumbosacral and sacrococcygeal junction and sacrum.

MRI demonstrates relative sparing of the disc space and at the same time, involvement of the vertebral bodies on either ride of the disc. Dissection of the anterior soft tissues, with abscess formation and collection and expansion of granulation tissue adjacent to the vertebral body, is highly suggestive of tuberculosis. MRI studies are more able to reveal epidural abscesses, compression of nerve root or compression of spinal cord.

Tubercle bacilli grow slowly in culture and confirmation may not be available for 6 to 8 weeks. However newer methods of culture in liquid media with radiometric growth detection (BACTEC 460) and the identification of isolates by nucleic acid probes a high pressure liquid chrompatophy of mycolic acid, help make reports available in 2-3 weeks.

Polymerase chain reaction (PCR) testing is highly specific for tuberculosis bacillus and provides rapid confirmation of a positive culture.

DIFFERENTIAL DIAGNOSIS:

Following conditions have to be considered for differential diagnosis.

1. *Traumatic compression fracture:*

Normally, the anterior wedging of vertebra and no involvement of the disc space help. These fractures can be of multiple vertebrae and no abscess shadow or paravertebral mass is visualized on x-ray examination.

2. *Pyogenic Osteomyelitis:*

Clinical presentation is acute with high rise of temperature. The ESR is well above 100mm/m. There is possibility of septicemia. Radiological destruction is limited to one or two vertebrae and the abscess is limited to just one area.

3. Salmonella Osteomyelitis:

This can be easily missed. Sickle cell disease individuals are more prone to get it. Drainage of abscess and culture of organism helps to establish a diagnosis.

4. Mycetoma Actinomycosis:

It is a rare condition and difficult to differentiate. The diagnosis needs a radical laminectomy and biopsy examination.

5. Brucellosis:

Drainage and culture of bacilli are needed.

6. Luetic:

A rare condition confirmed by blood examination for syphilis.

7. Echinococcus:

The type of destruction in vertebral body is as punched out with concomitant destruction of the disc space. Soft tissue extension and hepatic involvement are present.

8. Chronic Infection:

Rheumatoid (Seronegative) involvement and ankylosing spondylitis can be differentiated with haematological investigation, no abscess shadow is seen radiologically.

9. *Metabolic skeletal osteoporosis:*

Senile, postmenopausal, the density of bones is decreased, loss of osseous trabeculae is noted. No paravertebral mass or abscess shadow is noted. It is important to exclude hyperthyroidism and hyperparathyroidism (primary or secondary) as cause of compression fractures of vertebrae. In all these problems, the interverteberal disc space is well preserved. The same is true of cortisone induced osteoporosis.

10. *Tumours of the vertebral column:*

Either benign or malignant may have to be differentiated from skeletal tuberculosis. Malignant lesion may either be primary or secondary.

All malignant tumours have a characteristic bone destruction pattern but the intervertebral disc space is well preserved.

The other possible pathological lesions that might simulate tuberculosis of spine are osteochondritis of the scheurmam type and hemivertibrae. These are rare lesion and have specific radiological appearance that help diagnosis.

TREATMENT

Antituberculosis drug regimens:

The Medical Research Council of the United Kingdom carried out a series of trials in the late 60's and early 70's to establish the antituberculosis regimen necessary for treatment of tuberculosis lesion of bones and joints. Though the emphasis in the trials was primarily on tuberculosis spine, the recommendations are for all types of musculo-skeletal lesions. Briefly, there is a four drug regimen for the first three months with dosages of the drugs based on age and body weight of the patient. The drugs of choice are Rifampicin, Isoniazid, ethambutol and pyrazinamide, followed by three drugs i.e., Rifampicin, isoniazid and ethambutol for 16 to 24 months if toxicity develops, the offending drug is changed. Allergic reaction can occur to any drug; careful attention, must be paid to toxicity. Thus streptomycin can effect the VIII nerve resulting in deafness or vestibular functional derangement. Rifampicin can produce hepatotoxicity and hence SGOT & SGPT levels must be monitored. Ethambutol can produce depressed thyroid function.

The major aim of treatment is to prevent paraplegia. Most authors have adopted the use of 4 anti-tuberculosis drugs for a period of three months initially followed by three drugs for 18 to 24 months. The drugs used are streptomycin, rifampicin, Isoniazid, ethambutol and pyrazinamide in children below the age of 12 years. Both streptomycin and rifampicin are advocated by pediatricians. The commonly followed treatment modality is the middle path. i.e., bed rest, drugs, periodic review of progress by x-ray and ESR done every 4 weeks. A careful detailed neurological examination every 3 or 4 days is mandatory. If there is an increase in neurological deficit, surgical intervention is desirable.

AUXILLARY TREATMENT:

Steroids are not recommended to be given routinely. Short term steroid therapy can be given in patients who are in a moribund state, till anti-tuberculosis treatment starts acting or when patchy meningitis is present. The addition of steroid might prove crucial. Short term therapy with anabolic steroids in debilitated malnourished patients enhances the protein intake but it should avoided in women and children.

Indications for surgery being:

1. Neurological complications which fail to respond to conservative care.
2. Paraplegia of the flexor spasm type, with bladder and bowel involvement and sensory deficit.
3. Neurological status remaining static or
4. Where the diagnosis remains doubtful.

5. Mechanical instability after healing.

6. Recurrence of the disease

7. Multiple vertebral involvement in children with severe kyphosis.

The various techniques of surgical treatment are

1) Costo-tranversectomy where there is a large abscess in the thoracic regions.

2) Antero-lateral decompression for the paravertebral mass, either an abscess or granulation tissue. The technique is primarily an extra pleural exposure of the abscess/granulation tissue and the vertebral lesion, and the partial excision of the vertebral body. So that the pressure on the cord is relieved. Normally 2 or 3 ribs are removed for about 2 to 3 inches at their vertebral end. The intercostal artery and nerve are identified and ligated. The cord with its covering membranes exposed anteriorly and laterally so that the pulsation of the cord commences after the decompression. The vertebra are then fused with the resected ribs. This is the commonest procedure used in this country.

3) Transthoracic anterior decompression:

The anterior approaches initially described by Hodgson (1915-1993) has created lot of interest among ortho surgeons today.

For lesions in the cervical spine extending from the fourth to the sixth cervical segment, the lateral approach described by Hodgson and associates to preferred.

To reach thoracic lesions between the seventh cervical and the fourth thoracic vertebra, a periscapular approach similar to that used for a first - stage thoracoplasty is employed. The side of the approach is usually right ride for lesion above D5.

For lesions below the level of the fourth thoracic vertebra, the approach to usually on the left side. Usually approach is thro' the rib bed 2 levels above the apex of the lesion.

For thoraco-lumbar region between the eight thoracic and third lumbar segments. The ninth rib is removed and as a rule, the diaphragm is divided along its posterior attachment.

Another satisfactory approach is described by Fey. The eleventh rib is removed, providing satisfactory access to lesions from the eleventh thoracic down to second lumbar vertebra. In this procedure for adequate exposure of the vertebral bodies the psoas muscle must be detached at its upper end and turned downward. In this region, it must be remembered that the lumbar arteries and veins are located at the level of the centre of their corresponding vertebral bodies and must therefore be controlled as the bodies are approached.

For disease involving the second to the fourth or fifth lumbar vertebra, the twelfth -rib incision of Digby is also used.

Another way to approach the middle lumbar vertebra is to use the conventional renal incision. Through it one can expose adequately the first to the fifth lumbar vertebrae.

Anterior cage fixation and posterior instrumentation have been done and described in various literatures. Anterior instrumentation which have all along been used in deformity correction has been used in caries spine in our study. To understand the basis of instrumentation, we should first know about biomechanics of spine and biomechanics of anterior instrumentation.

BIOMECHANICS OF SPINE[4]

Intervertebral load transmission through the thoracolumbar spine is a complex condition of spinal balance between the anterior, middle and posterior spinal column. In the neutral position, approximately 80% of the spinal load is transmitted through the posterior facets. However, postural charges, conditions of facet or disc degeneration or spinal destabilization and reconstruction may alter these load-bearing properties significantly. The thoracolumbar spinal loading paths are coupled intricately with the kinematics of the motion segments, as the anterior and posterior musculoligamentous constraints serve to actively and passively control three-dimensional multidirectional flexibility of the functional spinal units. The axis of intervertebral rotation during flexion and extension in the frontal plane has been shown to range from the anterior 1/3 to the middle osteoligamentous column of the intervertebral disc.

BIOCHEMICS OF SPINE INSTRUMENTATION[2]

Spinal implants are used to apply corrective forces, to maintain the correction achieved, and to provide the necessary rigidity to optimize rates of arthrodesis. All spinal implants serve as temporary internal splints. The failure to achieve union will result in prolonged cyclical loading which ultimately results in fatique failure of the implant. These devices share loads with the spine in a dynamic relationship in which the implant initially bears most of the load. Implant loading gradually diminishes as healing progresses and should be minimal after consolidation of the fusion mass.

Via their attachment sites to the spine both anterior and posterior implants may apply corrective forces including distraction, compression and translation.

Posterior implants gain purchase through placement of hooks on the pedicles, laminae, or transverse process or by threading of wires around the lamina or through the bases of the spinous process and by placement of transpedicular screws.

Posterior fixation, works at an increasing distance from the axis of intervertebral rotation, affords greater leverage and resistance to motion about the instantaneous axis of rotation. Inadequate anterior column support however, leads to a potentially unstable mechanism and an instrumentation load - bearing configuration.

Anterior devices generally rely on single vertebral body screws. As the bone-implant interface is within the cancellous vertebral body, these systems may be inherently less stable than posterior constructs. Mechanical studies assessing anterior vertebral screws have revealed maximal stability is achieved with bicortical purchase but with the addition of a staple preparation of far cortex is not necessary.

Evolution of anterior system[2]:

The first system was developed by Dwyer and included vertebral body screws and a braided titanium cable, used in scoliosis correction. Significant loss of correction occurred in upto 40% of patients. The flexibility of the system resulted in nonunion in upto 33% of cases.

Second system is the Zielke system[5], which used a semi-rigid, 3.2 mm threaded rod. This method relies on compression.

The need for further refinement led to the solid rod systems. The first was the Texas Scottish Rite Hospital (TSRH) system. A solid rod (4.8mm or 6.4mm) is precontoured and placed within the screws and tightened.

Most recently the dual rod constructs have been developed to further enhance rigidity while restoring the sagittal contour. The

Kaneda multi- segmental system used two semi-rigid, 4mm rods that are attached to triangulated vertebral body screws. The screws are placed through a vertebral plate at each level, improving the pull out strength by 50%.

For improving the strength of anterior single rod constructs, strategy involves the provision of structural anterior inter-body support, which may maintain anterior column length and improve stability.

Structural interbody devices include femoral ring allografts, titanium cages and traditionally used iliac crest and rib grafts.

Rib grafts and Iliac crest when used alone were found to collapse, in the long run.

Femoral ring allografts despite some early subsidence, maintained anterior column height. An in vivo study in sheep suggested that distraction could be maintained with titanium cages despite some loss of height in the early post operative period.

Yilmiz et al[13], Govender et al[3], have previously adopted this system of anterior instrumentation, which were used in spinal deformity correction in scoliosis for deformity correction in caries spine.

Oga et al[8], have conducted a study using six stainless steel discs and proved that biofilm formation by tubercule bacilli is less, so that antibacterial drug penetration on the tuberculosis bacillus is more and that implant can be used in a tuberculous focus, without an increase in the risk of infection.

Based on this study, posterior instrumentation, with anterior strut graft were done by several authors.

Anterior instrumentation used traditionally in scoliosis to maintain correction, was used in tuberculosis, by Yilmiz et al[13] and by Govender et al[3]. Based on their observation we have conducted this study.

MATERIALS AND METHODS

This study was conducted in Government General Hospital, Chennai from May 2002 to April 2006. 20 patients with tuberculosis spondylitis with neurological deficit for whom anterior decompression and stabilization was done; were assessed, out of which 13 cases where taken up for study. Females were marginally high in our study. Male to female ratio was 6:7.

The age group of the patient ranged from 15-60 years, mean age being 34.92. Table-I Dorsal Involvement was more in study Dorsal 8, Dorsolumbar - 3 and Lumbar - 2 (Table -II).

TABLE - I
DETAILS OF PATIENTS

Sex	***No. of patients***
Male	6
Female	7
Total	13

TABLE - 1A
AGE DISTRIBUTION

Mean Age range in years	34.92 (15 to 60 yrs)

TABLE - II
LEVEL OF INVOLVEMENT

Level of Lesion	***No. of patients***

D_3 - D_4	1
D_5 - D_6	2
D_8 - D_9	1
D_9 - D_{10}	3
D_{10} - D_{11}	1
D_{11} - D_{12}	3
L_1 - L_2	2
Total	13

INCLUSION CRITERIA:

We included cases of tuberculosis spondylitis, affecting dorsal, dorso-lumbar and lumbar spine which had been treated by anterior radical debridement and anterior fusion combined with anterior instrumentation. All patients had completed their course of antituberculous chemotherapy and had been followed up for a minimum period of 5 months.

The indications for surgery were a neurological deficit (progressive, complete or partial), a cold abscess detected clinically or radiologically, vertebral destruction with significant angulation and pain due to facetal disruption.

EXCLUSION CRITERIA:

All cases of cervical spine tuberculosis and those cases of dorsal & lumbar tuberculosis treated by conservative management were not included in the study.

Those patients with less than 5 months follow up were also excluded from the study.

Neurological assessment were made according to Frenkel's grading. Kyphus angles were recorded as Konstam's angle on plain lateral radiographs.

KONSTAM'S & BLEOVSKY METHOD:

The Kyphus angle is determined by drawing lines along the superior end plate of the normal vertebra above and the inferior end plate of the normal vertebra below. Usually these lines fail to intersect on the x-rays. So a construction method is adopted and perpendiculars are drawn to these lines and the angle made at their intersection is determined.

This method of determining Kyphus angle was used in few cases, whereas in cases where the x-rays were stored as images in computer, AutoCAD program was used and the angles obtained.

Auto CAD Program:

This is a computer design software used for structural drawings and for lot of other purposes. X-rays images are brought into the program, lines are drawn using the tools and the angles obtained.

Anterior fusion, graft height, graft related problems (fracture, absorption, subsidence and slippage) and implant related problems (loosening and breakage) were recorded and assessed.

All our patients had an involvement of 1 disc space level. So fusion 1 space above and 1 disc below was done. Totally 3 motion segments were immobilised in all our cases.

12 cases had an prevertebral abscess with an average about 70ml of pus (40-100ml) 1 case had only granulation tissue with no pus.

All patients were managed with anterior debridements decompression, interbody arthodesis with rib graft in 1 case, Iliac crest strut graft with zeta instrumentation in 6 cases and titanium cage with zeta instrumentation in 6 cases. Anterior instrumentation is done in the form of zeta (moss-miami system). The instrumentation consisted of rods and screws placed in the vertebral body and extended one level cephalad and one level caudad to the affected vertebrae. Staple washers were used to improve the stability of the construct.

TABLE - III
DETAILS OF ANTERIOR COLUMN RECONSTRUCTION

Type of Graft	***Number***	***Dorsal***	***Dorso Lumbar***	***Lumbar***
Anterior column reconstruction (ACR)				
Rib graft	1	1		
Iliac Crest graft	6	4	2	
Cage	6	3	1	2

OPERATIVE TECHNIQUE:

Right Sided Thoracotomy:

This approach was used in cases with lesions upto D5 Vertbera. It is a periscapular approach with incision through the third rib bed. Tributaries of the azygos veins needed to be ligated and the vertebra approached and debridement done.

Left thoracotomy:

For D5 to D11 region, thoracotomy is performed on the left side, since the pulsating aorta, forms an excellent land mark for the vertebra. Usually vertebra is approached by resecting a rib two levels above the level of the lesion.

Extrapleural approach:

This approach was used between D_{11} and L_1 after excision of the 11^{th} rib. Diaphragm at its origin needs to cut for better exposure.

Retroperitoneal approach:

The lumbar region was approached retriperiotoneally, and psoas muscles erased from the transverse process. Vertebral intersegmental arteries which run across the middle of each vertebral body needs to be dealt with for exposure.

TABLE - IV
REGIONAL DISTRIBUTION

Level	***Number***
Dorsal	8
Dorso lumbar	3
Lumbar	2
Total	13

TABLE - V
SURGICAL APPROACH USED

Surgical approach	***Number***
Right Thoracotomy	3
Left sided thoracotomy	5
Extra Pleural	3
Retro Peritoneal	2
TOTAL	**13**

OBSERVATION

The average operating time was 3.7 hours (2.5 hours - 5 hours) and the average blood loss was 525ml (range 250-300ml for thoracotomies) and 500-600ml for retroperitoneal approaches).

Post operatively, histopathological examination of the caseous material and the involved vertebra was done, and the diagnosis was confirmed.

All patients were started on 4 drug course of chemotherapy. INH - 300mg, Rifampicin - 450mg, Ethambutol-800mg, Pyrazinamide-1g preoperatively and continued post operatively till suture removal. Then the patients were registered under RNTCP programme and treatment continued at home.

The patients were nursed in bed in the post operative period, and were made to sit up with braces after suture removal on the 12th post operative day. The brace was advised to be worn for a minimum period of three months.

Lateral and antero posterior radiographs were made in the immediate post operative periods, at six weeks and at three months; after which they were made to come every six months until the time of the latest follow-up evaluation.

The presence of fusion was determined by the absence of localized pain and tenderness over the site of arthrodesis, the maintenance of correction of deformity and evidence of fusion on radiographs. The erythrocyte sedimentation rate was monitored for the presence of an active disease process.

Neurological examination was performed at each follow up visit with the use of the classification system of Frankel et al. According to this sytem

Type A - Indicated a complete spinal cord injury.

Type B - A spinal cord injury with only sensation preent.

Type C - An injury with motor function present but not useful.

Type D - An injury wish useful motor function

Type E - An injury with intact neurological function.

Length of the graft varies from 2.5cm to maximum 4 cm. in all the cases 3 vertebral motion segments were fused.

RESULTS

Of the 13 patients who had involvement had an pre-operative kyphosis that ranged from 6^0 to 38^0 with a mean of 19.81. Post operatively the kyphosis ranged from 1^0 to 25^0 with a mean of 10.31. At follow up the kyphosis ranged from 4^0 to 26^0 with a range of 16.79.

All cases showed a progression of the kyphus angle, i.e. there was loss of correction in all cases. The loss of correction varied from 1^0 to 17^0.

The correction achieved was calculated by subtracting pre operative Kyphus angle from post operative angle.

The final correction was calculated by subtracting the loss of correction of the kyphosis from the degree of correction achieved at operation. The mean final correction was 6.38^0 (-10^0 to 24^0).

There was negative final correction in two cases (i.e. loss of correction more than correction achieved) in 2 cases and in one case the final correction was zero (i.e. loss of correction equal to the correction achieved).

Of 2 cases in the lumbar region, one case had an deterioration of correction to -10^0 over 19 months period and the other case had O^0 correction over 5 months period.

One case in the Dorso-lumbar region had an negative correction of -2^0, in which there was slippage of cage.

Correction was well maintained in the dorsal region, than in Dorso Lumbar and lumbar region.

Rib graft was found to be inferior, subsidence of graft occurred is one case. This leads to increase in Kyphus angle.

Maximum correction occurred in the dorsal region and the correction was also well maintained in the dorsal region.

Dorso lumbar region also had a good correction, but one case had a slippage of cage, which increased the kyphus angle.

Lumbar region had an negative correction, in the two cases which we have done one case lost the correction it had achieved and the other case had more loss of correction.

Maximum correction obtained in our series was 26^0, which was achieved in D_{10}- D_{11} region.

Neurological recovery:

Preoperatively 2 cases were in grade A, 7 in Grade B, 3 in Grade C and 1 in Grade E. 10 out of 13 cases showed complete recovery. 7 cases achieved a Frenkel grade E and returned back to their normal activities. One patient was a known case of post polio residual paralysis he regained his normal power which was Grade D and returned back to his daily activities.

Frenkel	***Pre Op***	***Follow up***
A	2	1
B	7	1
C	3	-
D		2
E	1	9

One child regained upto Grade D power at three months follow up and is still under active physiotherapy at home.

One case recovered completely regained normal power grade E. But progressively deteriorated and returned to Grade B. This was the case in which rib graft was used.

One patient had preoperatively and post operatively normal power.

Two cases which preoperative neurological Grade A, one case did not recover at all. Both of them developed sacral pressure sores and were treated wit flap cover. One patient died of pressure sores at 6 months following surgery.

The other patient had co-existent Tuberculosis meningitis also for which she was operated at NIMHANS, Bangalore. She had sensory recovery alone, and was lost for further follow up after the last flap cover.

There was one case of superficial wound infection; which healed with antibiotics and dressing alone.

Consolidation of the graft occurred at an average of 3 to 5 months following surgery. Subsidence of the rib graft was found in the only case, in which we used it.

Three patients died during follow up. One patient died as a result of pressure sore and its complications. One patient died of myocardial infarction 1 year following surgery, and the other patient died of fungal granuloma of the eye which had infected the cavernous sinus and died.

TABLE - VI
MEAN (RANGE) KYPHUS ANGLE (DEGREES) BEFORE AND AFTER OPERATION & AT FOLLOWUP

Level	***Number***	***Pre Op***	***Post Op***	***Follow up***
Dorsal	8	25.75 (16 to 38)	13.75 (9 to 25)	15.38 (11 to 26)
Dorso-Lumbar	3	23.67 (11 to 36)	12.67 (7 to 22)	20 (10 to 26)
Lumbar	2	10 (6 to 14)	4.5 (1 to 8)	15 (14 to 16)

TABLE - VII
MEAN (RANGE) CORRECTION, LOSS OF CORRECTION (LOC) AND FINAL CORRECTION (DEGREES) OF THE KYPHUS ANGLE

Level	***Number***	***Correction***	***LOC***	***Final correction***
Dorsal	8	12 (3 to 26)	1.75 (0 to 3)	10.25 (1 to 24)
Dorso-Lumbar	3	11 (2 to 17)	7.33 (1 to 19)	3.67 (-2 to 12)
Lumbar	2	5.5 (5 to 6)	10.5 (6 to 15)	−5 (– 10 to 0)

ILLUSTRATION

CASE – I :

60 years old lady presented with D_9 - D_{10} caries spine, anterior decompression and stabilization with Zeta and Iliac crest was done. Patient had Good recovery. This case has the longest follow up - 42 months.

CASE - II:

38 years old female presented with D_{10} - D_{11} caries spine. Anterior decompression and stabilization with Zeta and Iliac crest was done. Good recovery was seen in this case. This patient died of fungal granuloma of the eye.

CASE - III:

40 years old male, a known case of post polio-residual paralysis presented to us with paraparesis with involvement of D_9 - D_{10} level. Anterior decompression and stabilization with Titanium cage and Zeta instrumentation was done. Good recovery.

CASE - IV:

13 years old boy presented with paraparesis with flexor spasm of both lower limb with intact sensory with involvement of D_5 - D_6 level. Titanium cage and Zeta rode instrumentation was done. Patient showed recovery from Grade B to Grade D.

DISCUSSION

The prevalence of spinal tuberculosis has been increasing every year. Despite the good results of medical treatment with regard to eradicating the micro organism, kyphosis remains an unresolved problem. The insertion of strut grafts in the space created after debridement of the affected vertebral bodies provides some support anteriorly, but this is usually some what insufficient.

This has led to the use of posterior instrumentation for additional support either at the time of debridement or at a later stage. However, posterior instrumentation is associated with increased operating time, leading to greater blood loss, prolonged anaesthesia and increased post operative morbidity.

The use of anterior instrumentation can decrease the operating time, blood loss and post operative morbidity, at the same time give results comparable to posterior instrumentation.

Our study, though a small study consisting of 13 patients followed over a period of 5 months to 42 months. We have compared over study with Sundararaj et al[10], Yilmiz et al[13] study, Govender et al[3] study and Chen etal[12] study.

Adults were affected in 92.0% of cases which is comparable with 97.4% in Sundararaj et al[10], Chen et al study, but differs from the paediatric profile of Rajasekaran and Soundarapandian[9]; Oga et al[8].

The highest incidence of disease was seen in the dorsal spine (62%), comparable with Sundararaj et al[10] (57.15%), rather than the dorso lumbar spine reported by Tuli[14].

The mean preoperative kyphosis in the dorsal spine (25.75^0) was similar to that in Sudararaj et al[10] (26.9^0), MRC trial[7], Chen et al[12] reported a greater preoperative kyphotic angle of 33.1^0. Yilmaz et al[13] also reported a greater kyphotic angle of 59 degrees (range 34^0 to 77^0). Govendar et al also had mean preoperative kyphotic angle of 59^0.

The mean kyphosis in the lumbar spine 10^0 compared with Sudararaj et al[10] study (15.36^0) was less.

The mean surgical correction in the entire study was9.5^0, which is less than compared to 13.7^0 of Sudararaj et al[10], 23^0 Rajasekaran and Soundarapandian[9]. The amount of correction achieved has not been clearly mentioned in Yilmaz et al[13] study but has said to vary from (0 to 30 degrees).

Immediate post operative correction obtained in dorsal region in our study is 13.75^0 comparable to Sudararaj et al[10]15.86^0, Chen et al[12] had an average correction angle of 17.3^0, 15^0correction was obtained by Govender et al[3].

In Dorso-lumbar region post operative correction obtained in our study is 12.67^0, comparable to 14.6^0 in Sudararaj et al[10] study, and in lumbar region, our correction was 4.5^0 compared to – 1.28^0 in Sudararaj et al[10] study. Other studies have not clearly defined their post operative correction in dorso-lumbar and lumbar region.

At follow up, our correction in dorsal region has been well maintained at 15.38^0 compared to 20.25^0 in Sudararaj et al[10].

In Dorso-lumbar and lumbar regions our mean follow up values are 20^0 & 15^0 respectively, which showed more progression and are significantly higher values compared to 17.4^0 and 2.24^0 in Sudararaj et al[10] study.

The maximum correction achieved in our case was in the Dorsal region 26^0, whereas in the Sudararaj et al[10] study the correction was maximum 17.8^0 in the dorso lumbar spine.

A considerable loss of correction with anterior fusion has been reported by Rajasekaran & Soundarapandian[9], but with anterior fusion combined with anterior instrumentation and fusion, it has been less and comparable to posterior instrumentation and fusion.

The mean loss of correction in the dorsal spine in our series was 1.75^{0}, comparable to Yilmaz et al[13] 3^{0}, Chen et al[12] 3^{0}, and Sudararaj et al[10] 4.8^{0}.

In Dorso-lumbar region, we had a loss of correction 7.33^{0}, in one case there was negative correction due to cage slippage, which distorted our figures, and produced a higher loss of correction, compared to 2.8^{0} correction in Sudararaj et al[10], Govender et al[3] study showed a loss of correction from 5^{0} to 25^{0} as they progressed down the lower dorsal spine.

This could probably be attributed to the increased load transmission across the dorso lumbar region, where an rethinking about anterior instrumentation and use of global fusion is very valid.

We had only 2 cases in the lumbar region, of which one had negative correction (-10^{0}) and the other loss of correction O^{0}, comparing this Sudararaj et al[10] study of posterior instrumentation loss of correction of more than 10^{0} (12^{0}, 12^{0} & 25^{0}) has occurred.

This again brings to the fore, the doubt about the case of anterior or posterior instrumentation alone the in lumbar region. Probably global fusion is the answer to lumbar level caries spine.

Bhojraj et al's[6] observation that "Pedicle instrumentation have poor purchase in the osteoporotic bone about the infective focus" may still be valid. Still more cases needs to be done to find out the result.

There was slippage of cage in one case, compared to loosening of implant in Sudararaj et al[10] study.

ANTERIOR COLUMN RECONSTRUCTION
(ACR & GRAFT RELATED PROBLEMS)

The tricortical iliac crest was used in 6 patients, titanium cage with morsellized rib graft in 6 patients and rib graft in 1 case.

Despite an intact cortical shell, the weakness of rib grafts can be attributed to their unfavourable length width ratio, their curvature and the small surface area of contact witht eh adjacent normal vertebral end plates. The rib graft is subjected to excess loads with enormous forces transmitted across the graft and if it spanned more than two levels, graft fractures have been reported resulting in progressive kyphosis, Govender et al[3]. We had one case of graft failure following rib grafting.

Our incidence of infection is very less only one case had superficial wound infection which settled with antibiotics and dressing. This implies that there is no additional risk of persistent infection after adjuvant anterior instrumentation confirming the conclusion by Oga et al[8]. Further more Mycobacterium tuberculosis seems to have less affinity for stainless steel (SU316) than do pyogenic organism.

NEUROLOGY:

Neurological lesions were observed in 12 patients (92%) of which 8 (62%) recovered Frankel Grade E power, 1 patient who was a case of post polio residual paralysis regained back his normal power of Grade D. Two graded as Frenkel A, one of them unchanged after surgery, one had sensory recovery alone. One child recovered upto Frankel Grade D power at 5 months follow up.

Our results regarding neurological recovery are comparable with 78% of Yilmiz et al[13] study; 92% Sudararaj et al[10] study, and 91% of Chen et al study.

The average operating time in our study was 3.7 hours (3-4.5 hours 3 hours for Dorsal & 4.5 hours for DL & lumbar regions) compared 5 hours in Sudararaj et al[10] study for combined anterior and posterior surgery and 4.7 hours for Yilmaz et al[13] study. In Govender et al[3] study, the operating time was 3.5 hours which was comparable with our study.

The average blood loss during procedure was 525 ml (400-650ml, 400ml for dorsal region and 650ml for lumbar region) compared to 862 ml (347-1583ml) of Govender et al[3], 1000ml (500 to 1400ml) in Sudararaj et al[10] study. In Yilmaz et al[13]., the loss was at a higher level with 1560ml (778 to 3450ml)

Our patients were mobilized usually on the 12^{th} post operative day.

CONCLUSION

Based on the results of our study, we like to conclude that adjuvant anterior stabilization results in early mobilization and rehabilitation, thereby helping in reducing the morbidity of the patients.

Radical anterior debridement clears the diseased focus allowing reconstruction and restoration of the anterior column, as well as stabilization in the same sitting. Healing of the disease and fusion of the graft across the affected vertebra are hastened while neurological recovery is unaffected.

The incidence of graft - related problems and the progression of the kyphosis is significantly less when compared with anterior debridement and grafting alone.

The post operative loss of correction during follow up is insignificant for anterior stabilization in the Dorsal spine. For Dorso-lumbar and lumbar regions, global fusion involving both anterior and posterior stabilization will be the method of choice.

Intra or postoperative complications related to surgery were not seen.

These was no additional risk of infection with the use of implant anteriorly, even in the presence of large quantities of pus.

We believe that this regimen is to be recommended.

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PROFORMA

CS:

STUDY OF ANTERIOR DECOMPRESSION AND INSTRUMENTATION IN TUBERCULOSIS OF SPINE

Name: Age: Sex: IP No:

Unit:

Ward:

Address: Occupation: DOA:

DOS:

DOD:

Regional Distribution of spinal TB:

Neurological Status: Frenkel's Grade:

Vertebral Loss:

Kyphus angle: Pre-OP: Post-OP Loss of correction at follow up

Surgery performed:

Approach to spine:

Operative findings: Pus quantity/graduation tissue:

Duration of surgery: Blood loss:

No. of spine levels fused:

Ant. Column reconstruction (Cage/Graft used):

Length of graft/cage: Instrumentation used:

Length of hospital stay: Time of mobilization:

Complications: Pulmonary/Abdominal/Infection/Graft/Implant

Follow up:

Other remarks:

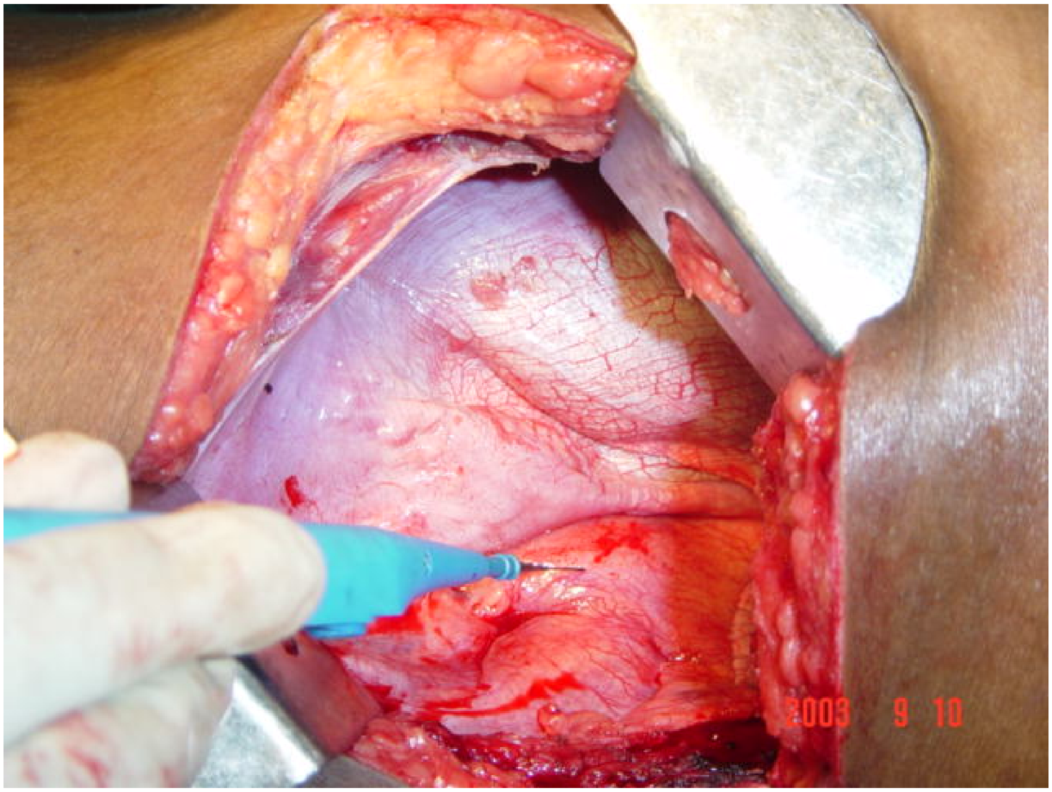
Neurological assessment:

MOTOR								
	Right	Left	Right	Left	Right	Left	Right	Left
Shoulder-Abd								
Elbow- Flex.								
- Ext.								
Wrist- Flex.								
- Ext.								
Hand Grip								
Hip - Abd.								
Add.								
- Flex								
- Ext.								
Knee - Flex.								
- Ext.								
Ankle - DF								
- PF								
EHL								
FHL								
Sensory system								
Reflexes								
Biceps								

Triceps								
Supinator								
Knee								
Ankle								
Plantar								
Creamasteric								
Abdominal								
Bladder								
Bowel								
Pressure sores								

MASTER CHART

S.No	Name	Age	Sex	I.P. No.	Unit	Ward	Period	Level of Lesion	Procedure	Neurological Grading		Kyphotic Angle			Correction achieved	Loss of correction	Period of follow up	Complications
										Pre OP	Follow up	Pre OP	Post OP	Follow up				
1.	Pitchammal	60	F	553661	I	19	22.7.02 - 6.9.02	D_9-D_{10}	Zeta with Iliac crest	B	E	18^0	15^0	15^0,16^0,16^0	3^0	2^0	42 mths	Nil
2.	Muthulakshmi	35	F	570090	I	19	4.11.02 - 4.12.02	D_8-D_9	Zeta with Rib graft	B	E,B	29^0	23^0	26^0	6^0	3^0	40 mths	Loss of Recovery
3.	Anbuchezian	40	M	614733	I	2A	19.8.03 - 10.9.03	D_{11}-D_{12}	Zeta with Iliac crest	A	A	11^0	9^0	10^0	2^0	1^0	6 mths	Died of pressure scores
4.	Murugan	18	M	674733	I	2A	22.12.03 - 4.2.04	D_{11}-D_{12}	Zeta with Iliac crest	B	E	36^0	22^0	24^0	14^0	2^0	17 mths	Nil
5.	Shyamala	38	F	6339733	I	19	11.12.03 - 12.1.04	D_{10}-D_{11}	Zeta with Iliac crest	B	E	35^0	9^0	11^0	26^0	2^0	17 mths	Died of fungal granuloma of eye
6.	Rani	51	F	664921	I	19	14.6.04- 2.9.04	L_1-L_2	Cage with Zeta	C	E	6^0	1^0	2^0,4^0,9^0,16^0	5^0	15^0	19 mths	Loss of correction
7.	Farzana	26	F	682324	I	19	17.9.04 - 12.10.04	D_9-D_{10}	Cage with Zeta	A	B	15^0	3^0	4^0	12^0	1^0	7 mths	Pressure sores
8.	Chinnadurai	49	M	675508	I	2A	13.7.04 - 24.8.04	D_3-D_4	Zeta with Iliac crest	C	E	18^0	3^0	4^0	16^0	1^0	12 mths	Died of MI
9.	Valli	24	F	679843	I	19	3.9.04 - 5.10.04	D_{11}-D_{12}	Cage with Zeta	B	E	24^0	7^0	11^0,16^0,21^0,26^0	17^0	19^0	18 mths	Slippage of cage
10.	Anandevel	40	M	689236	I	2A	3.10.04 - 8.12.04	D_9-D_{10}	Cage with Zeta	C	D	16^0	10^0	11^0	6^0	1^0	16 mths	
11.	Vetrivel	18	M	698369	I	2A	14.12.04 - 8.2.05	D_5-D_6	Zeta with iliac crest	B	E	38^0	23^0	26^0	15^0	3^0	14 mths	
12.	Rajiv Gandhi	15	M	788287	I	168	3.9.05 - 16.11.05	D_5-D_6	Zeta with cage	B	D	37^0	25^0	25^0	12^0	–	5 mths	
13.	Rajeswari	40	F	759721	I	234	8.9.05 - 5.10.05	L_1-L_2	Cage with Zeta	E	E	14^0	8^0	14^0	6^0	6^0	4 mths	Loss of correction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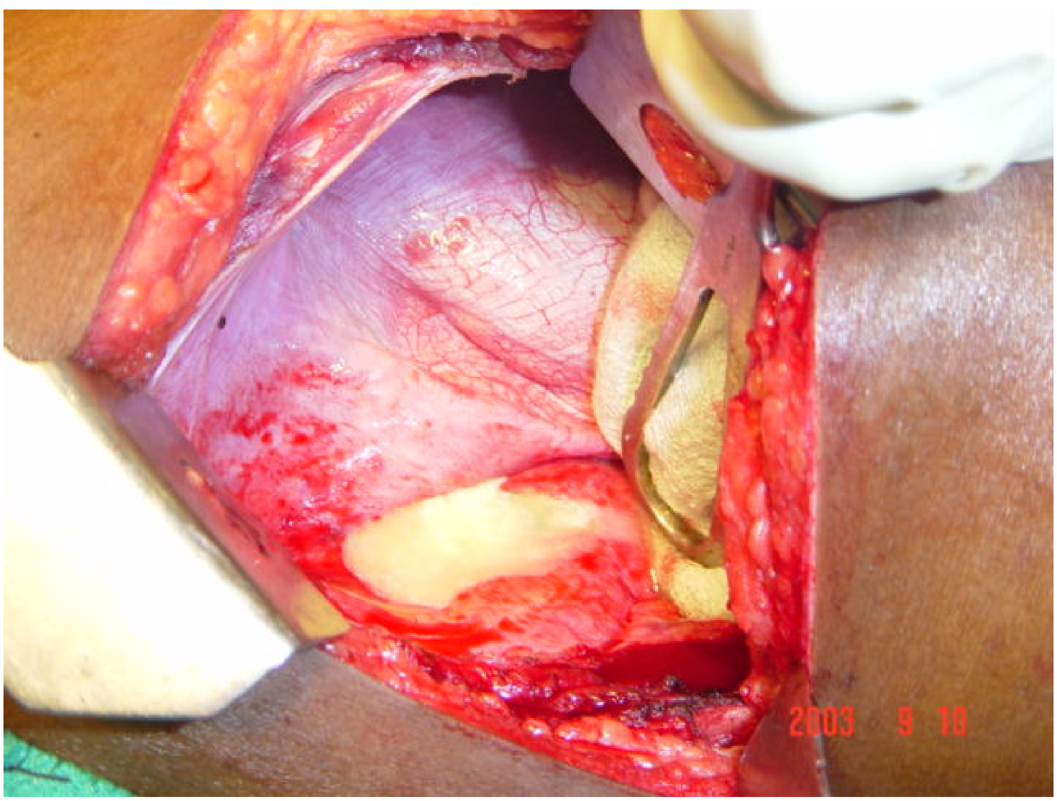
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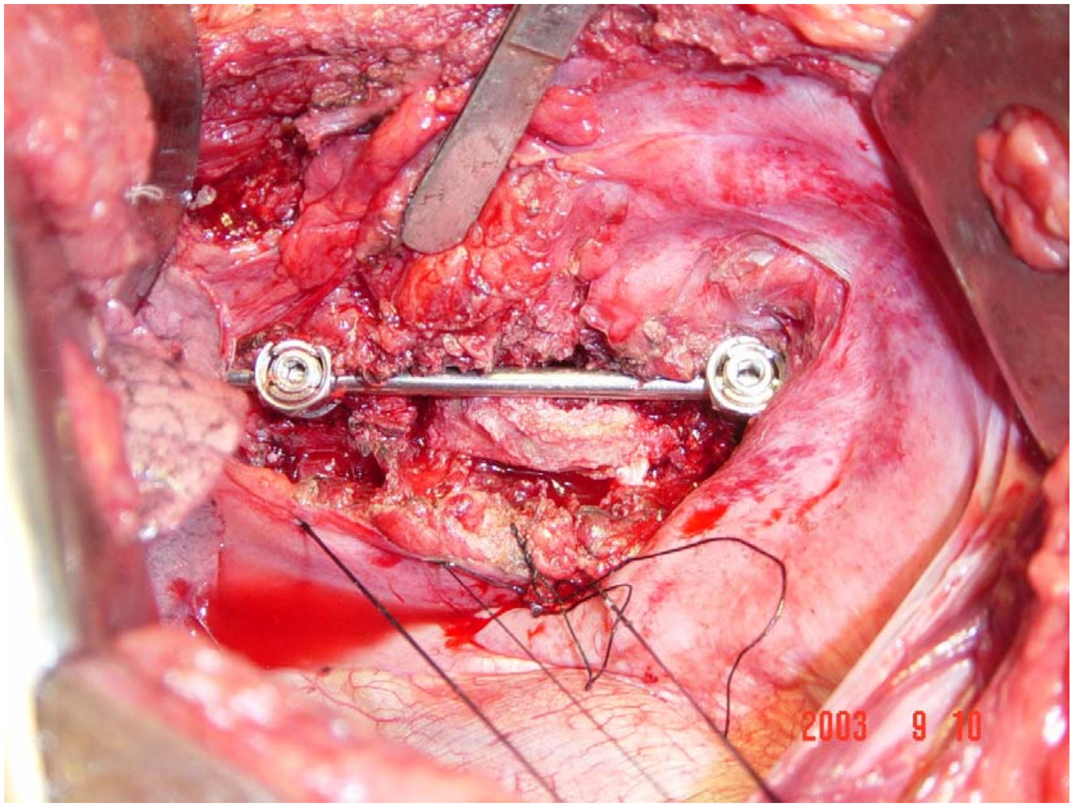
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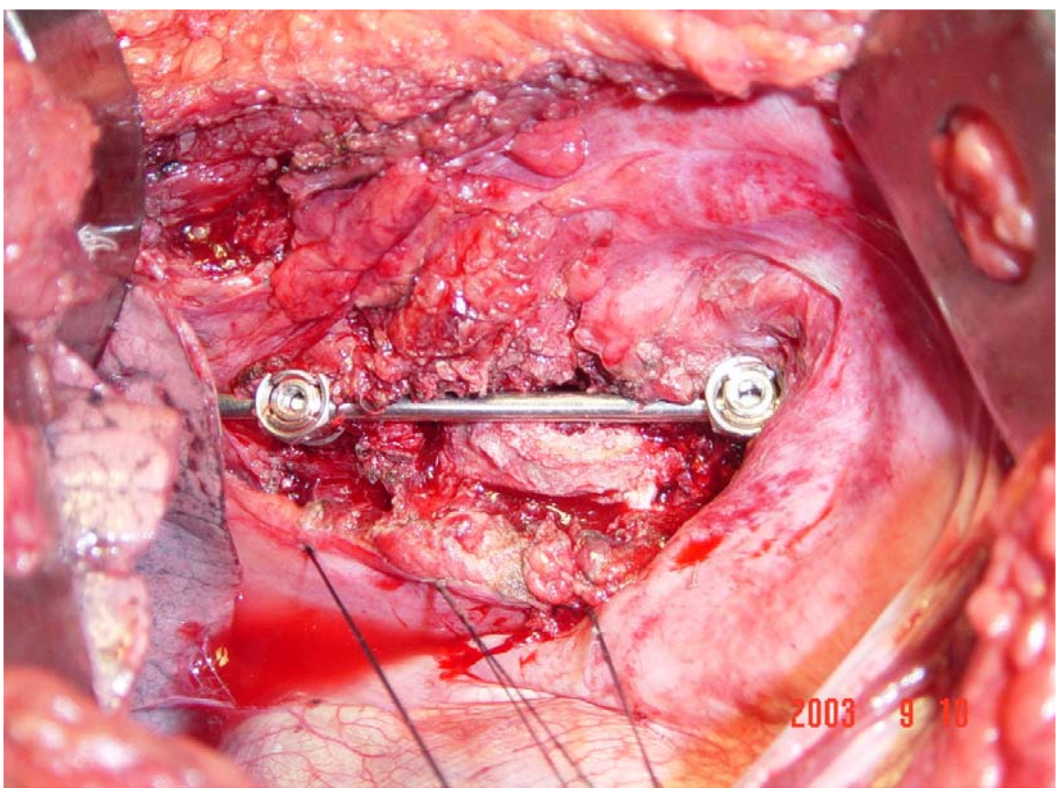
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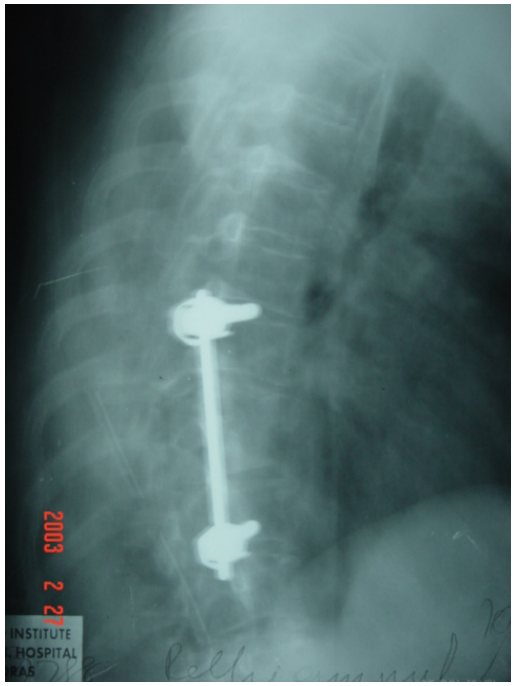
CASE - 1

PRE OP



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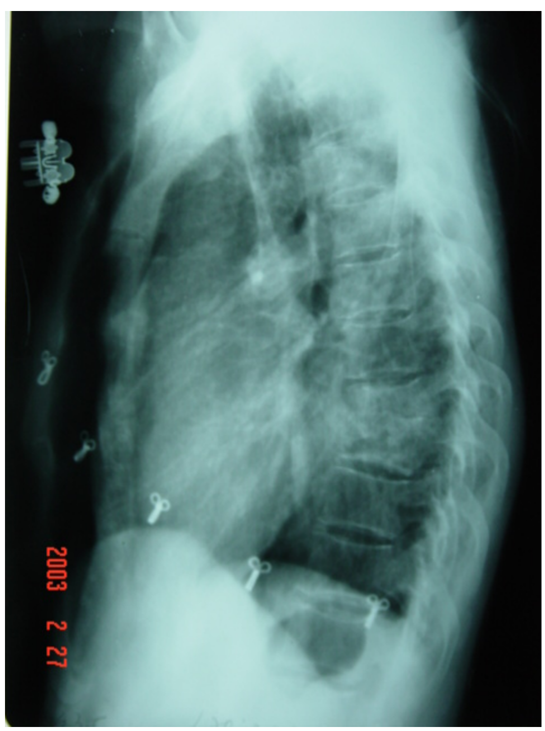
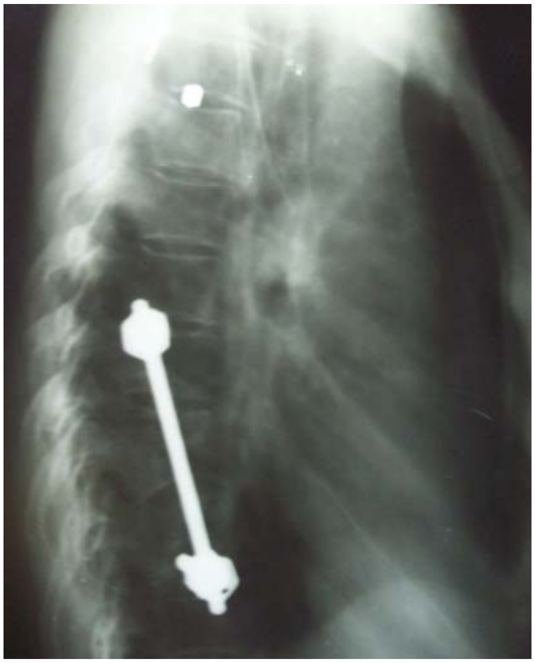
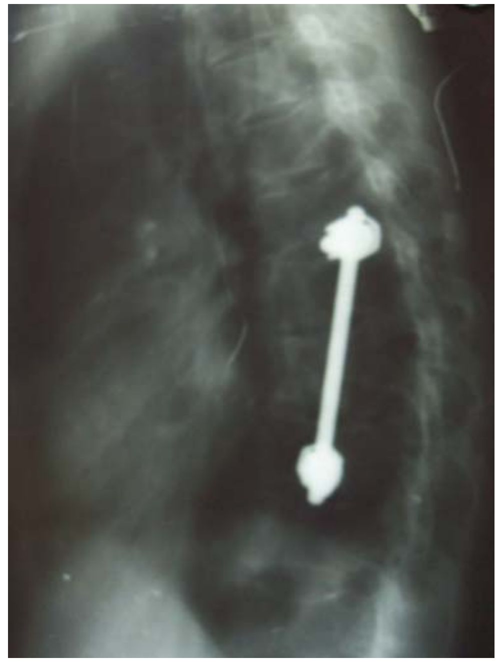


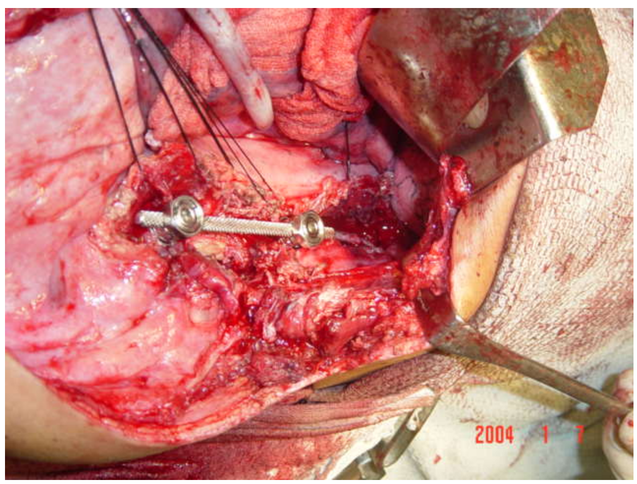
FOLLOW UP





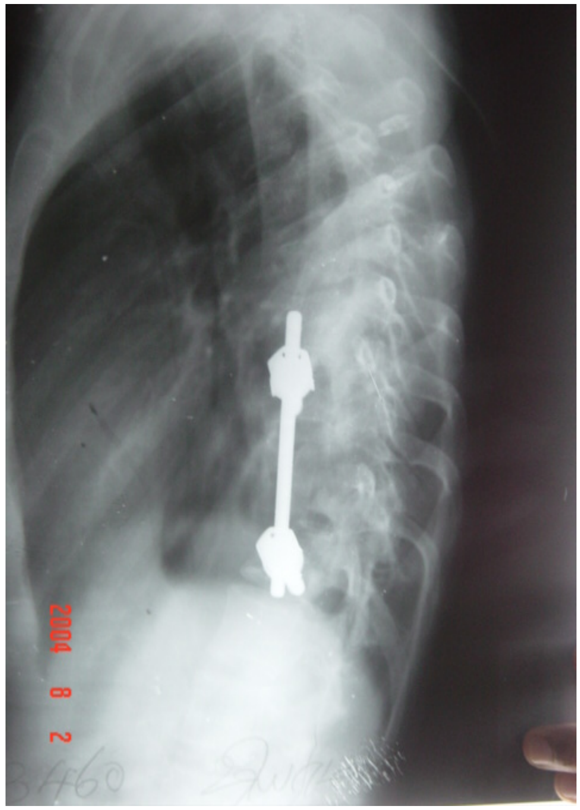
CASE II

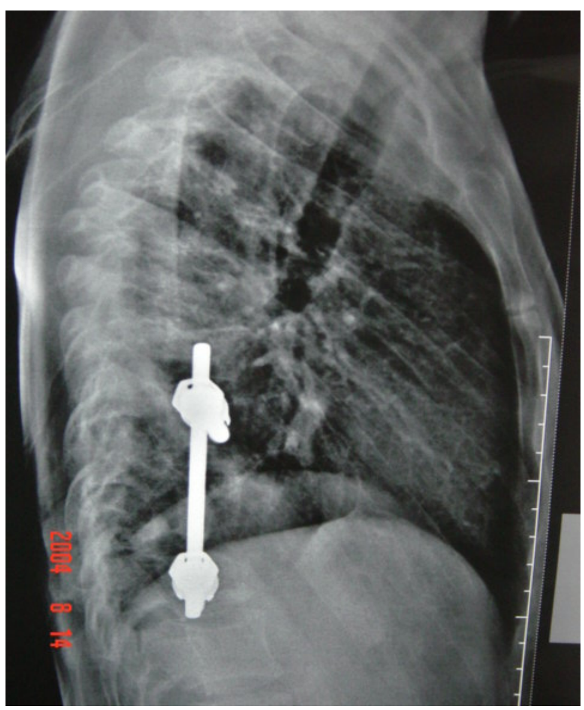
PRE OP



POST OP

FOLLOW UP



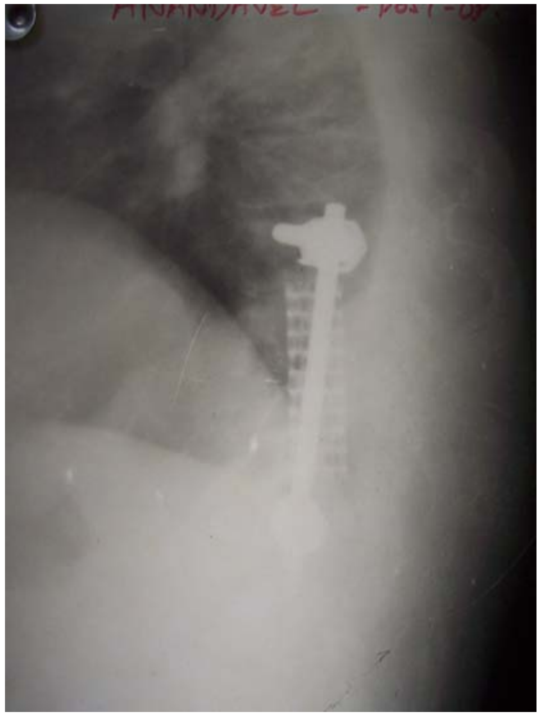


CASE III

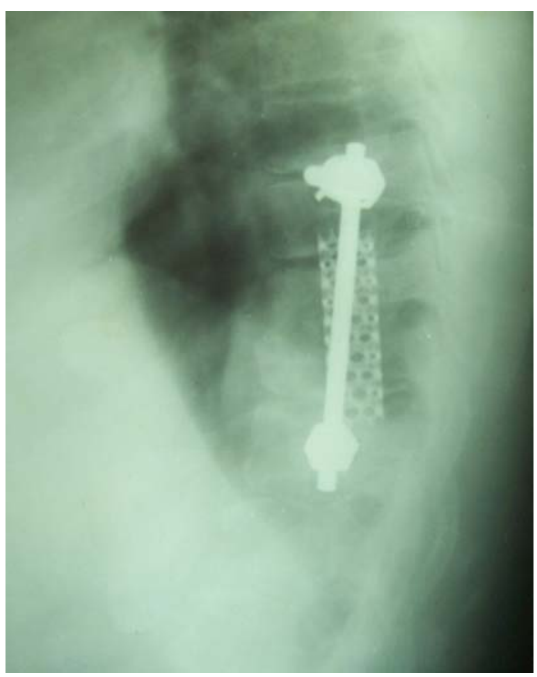
PRE OP

MRI SHOWING BLOCK

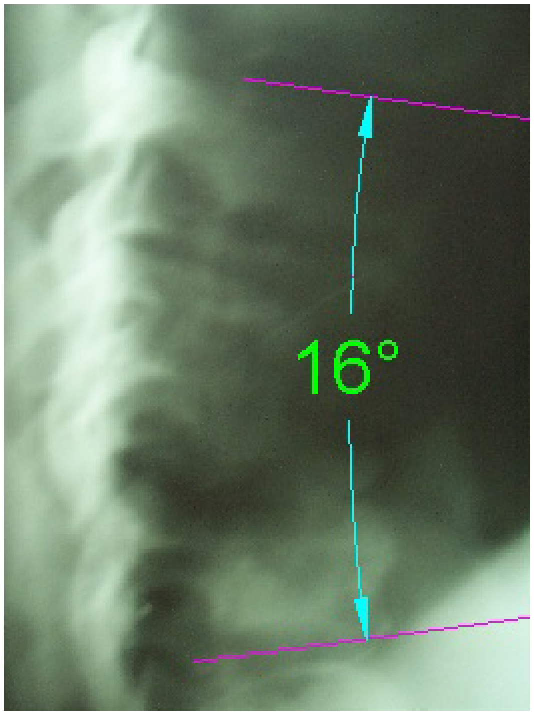
POST OP

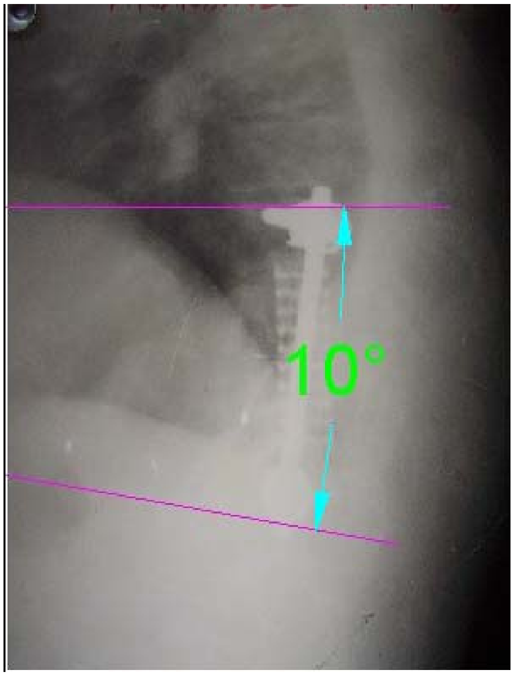


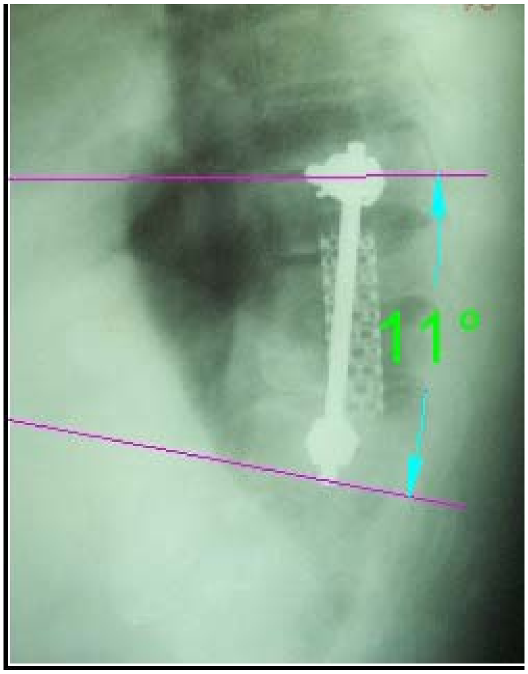
FOLLOW UP



ANGLES DRAWN USING AUTOCAD

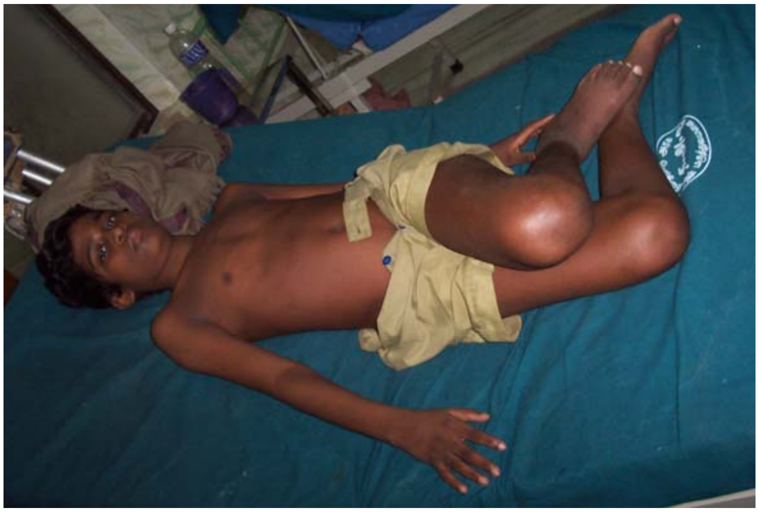




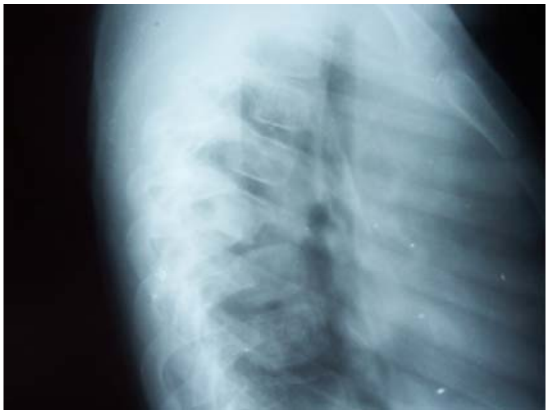


CASE IV

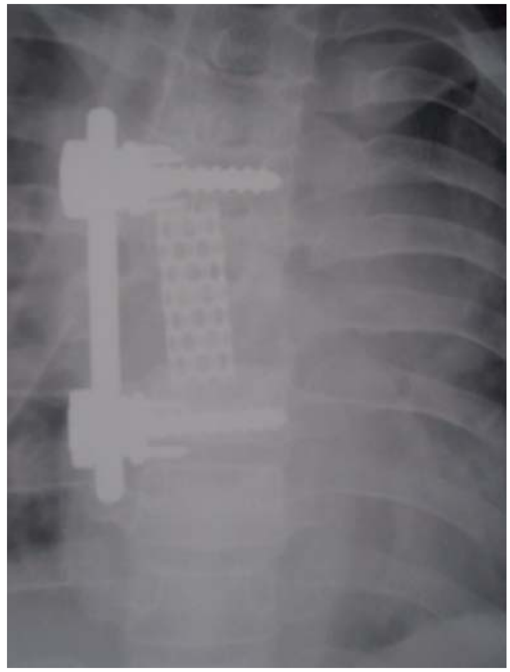
CHILD WITH FLEXOR SPASM



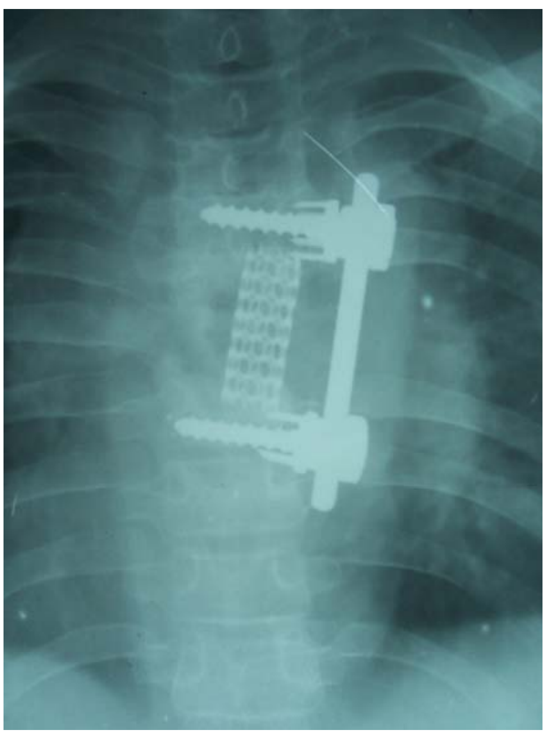
PRE OP



POST OP



FOLLOWUP

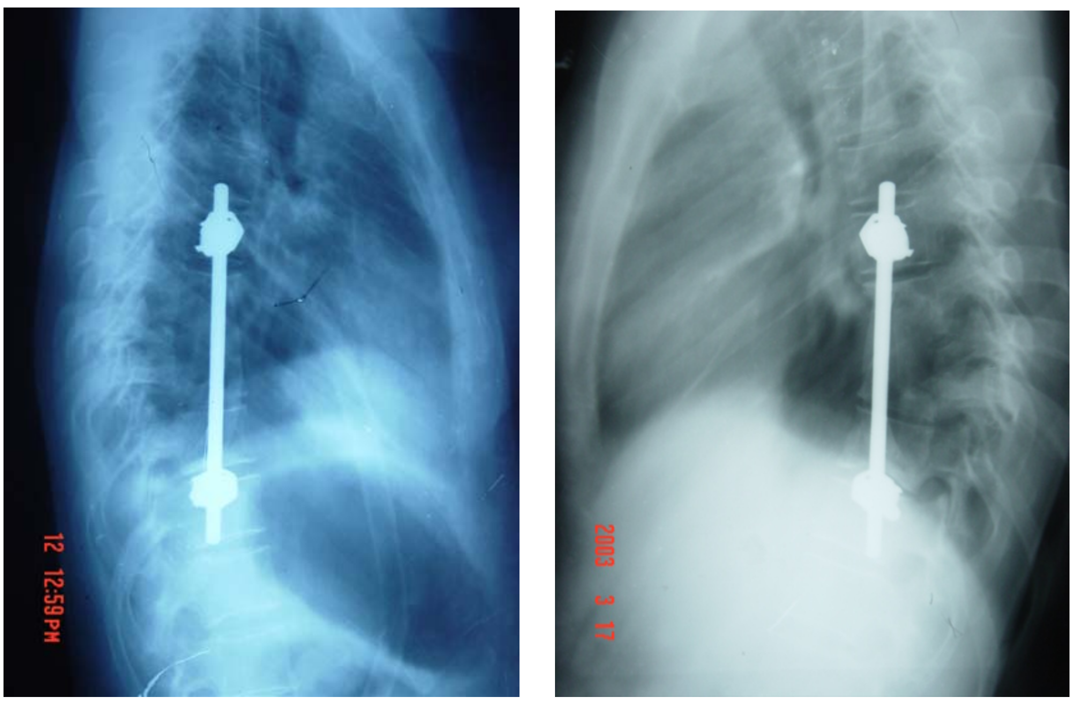


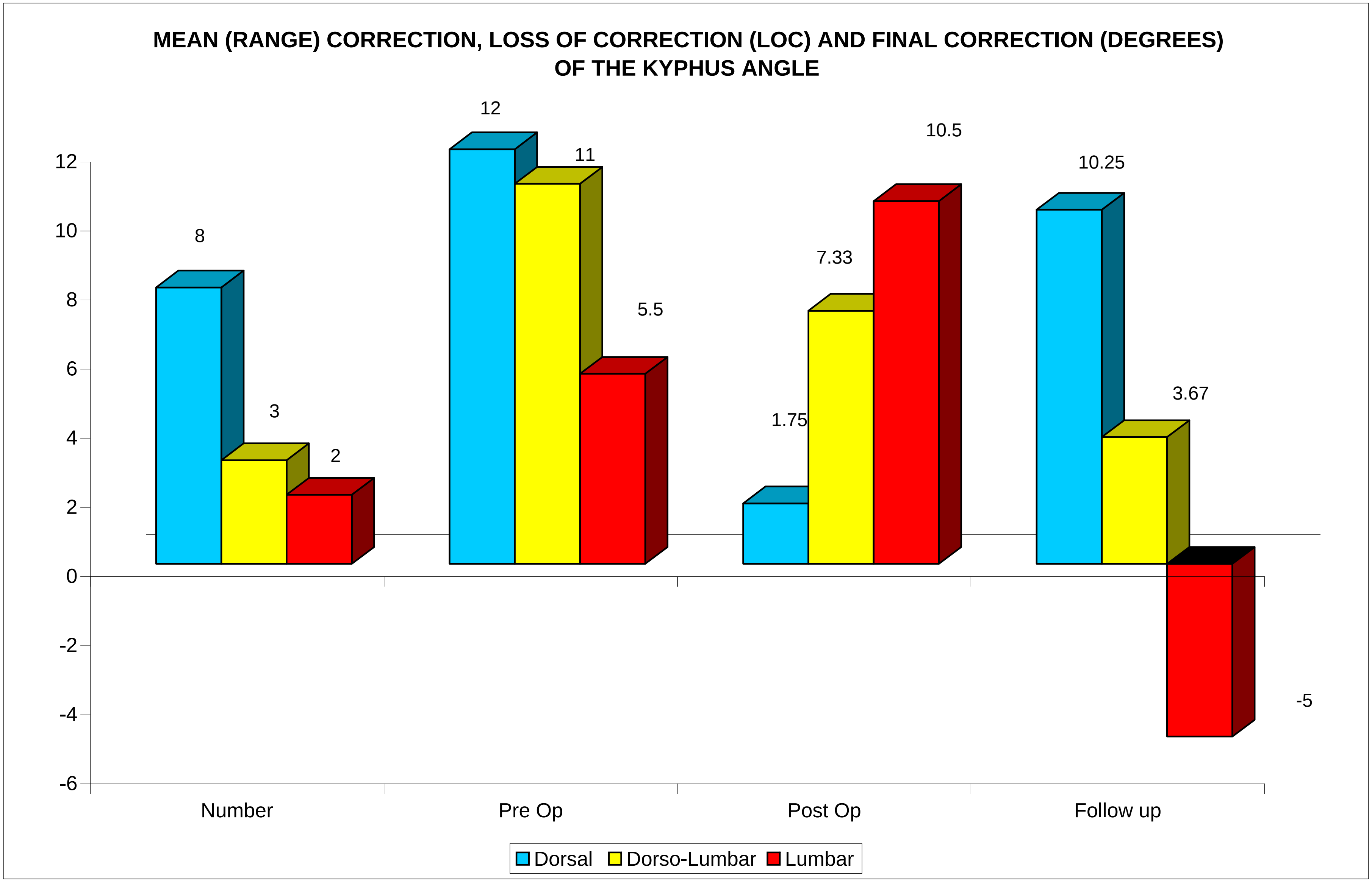
COMPLICATIONS

SLIPPAGE OF CAGE

<u>COMPLICATIONS</u>

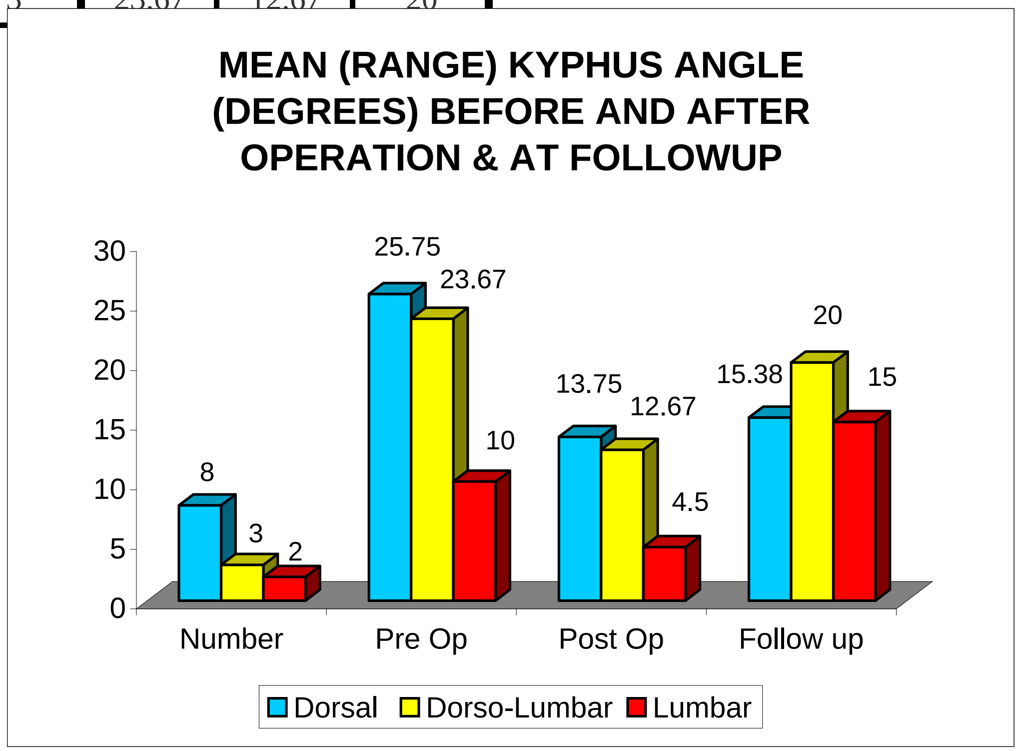
COLLAPSE OF RIB GRAFT

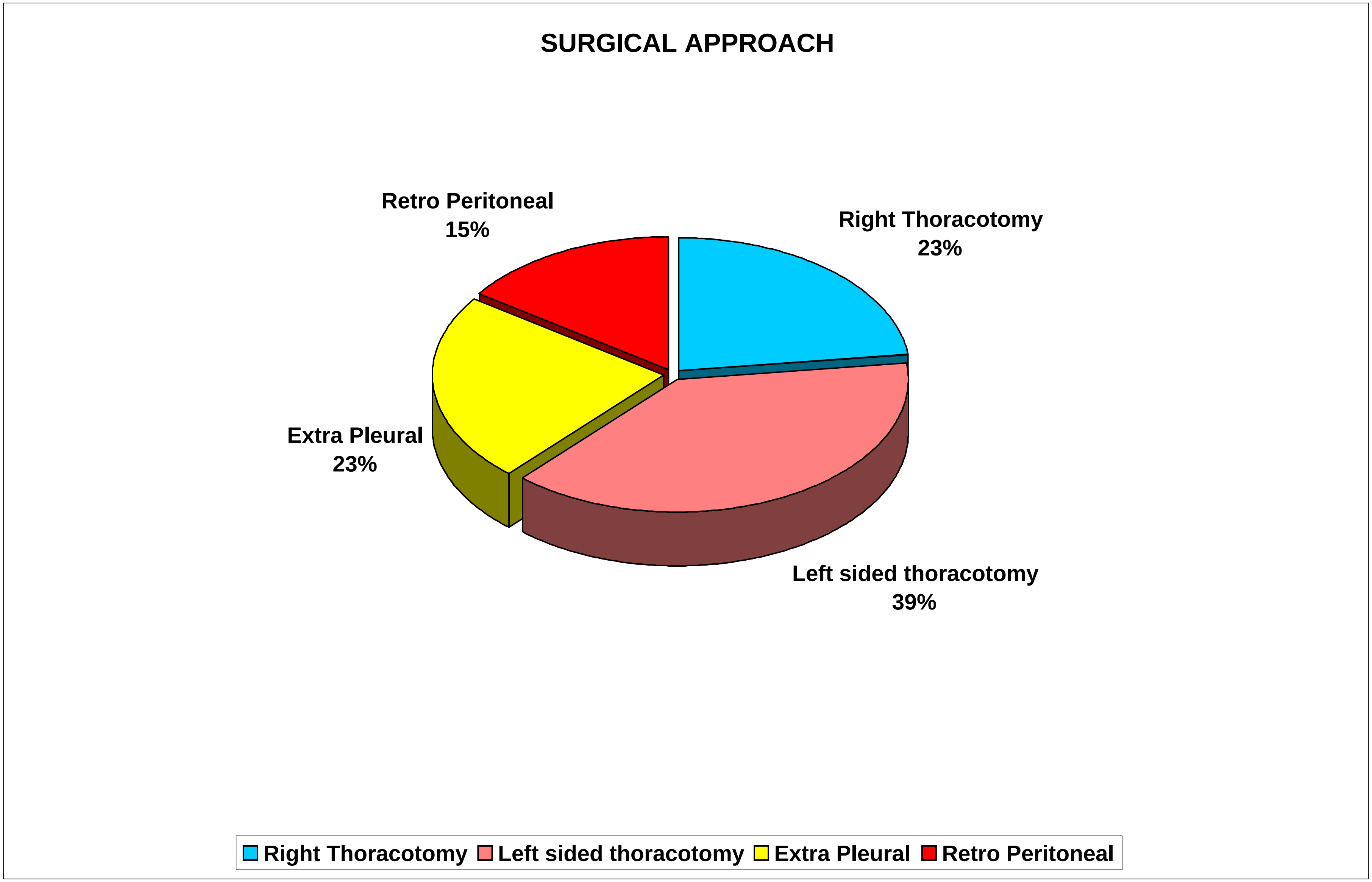


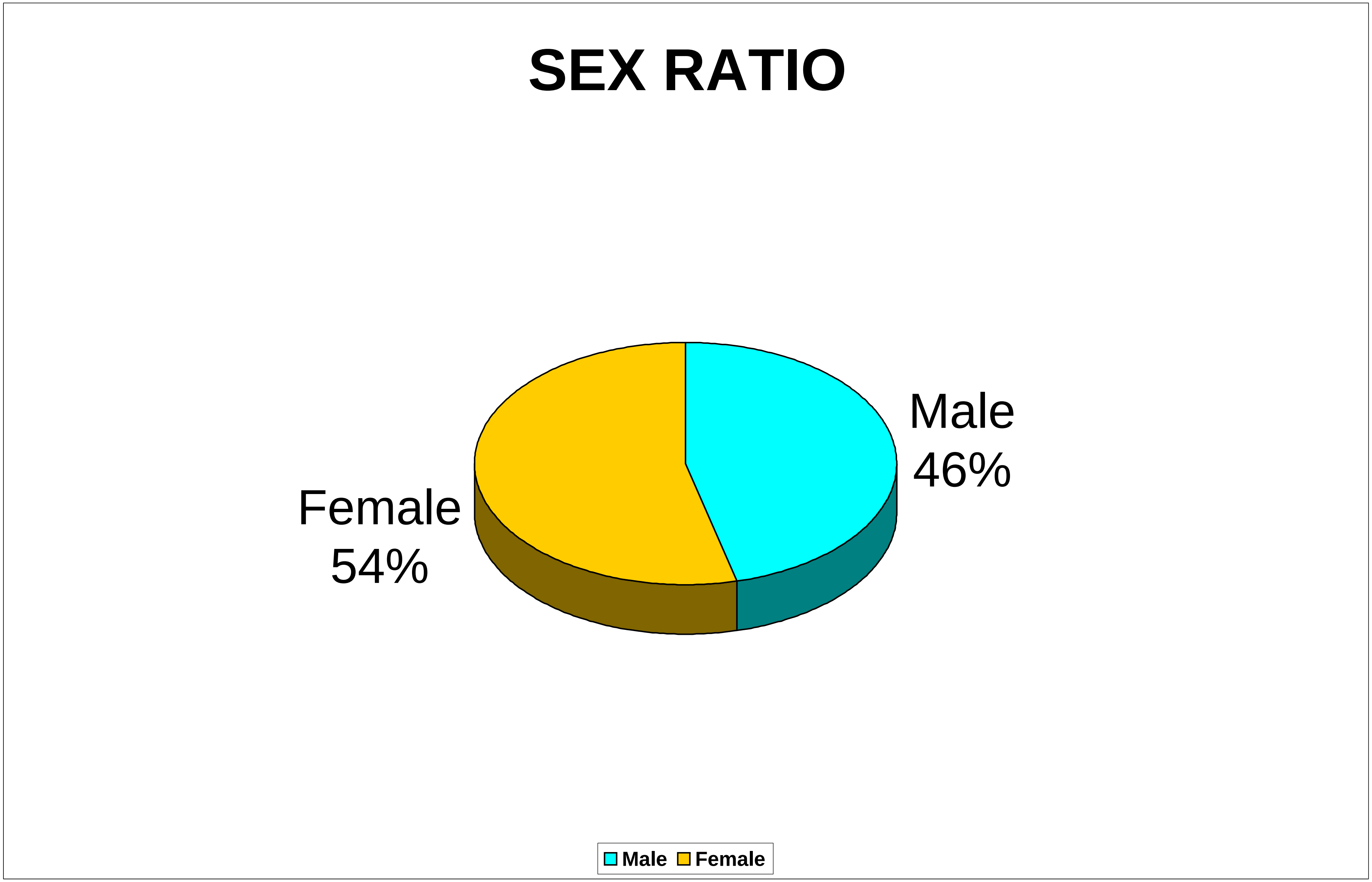


MEAN (RANGE) CORRECTION, LOSS OF CORRECTION (LOC) AND FINAL CORRECTION (DEGREES) OF THE KYPHUS ANGLE
12
10
8
6
4
2
0
-2
-4
-6
8
3
2
12
11
5.5
1.75
7.33
10.5
10.25
3.67
-5
Number
Pre Op
Post Op
Follow up
Dorsal
Dorso-Lumbar
Lumbar

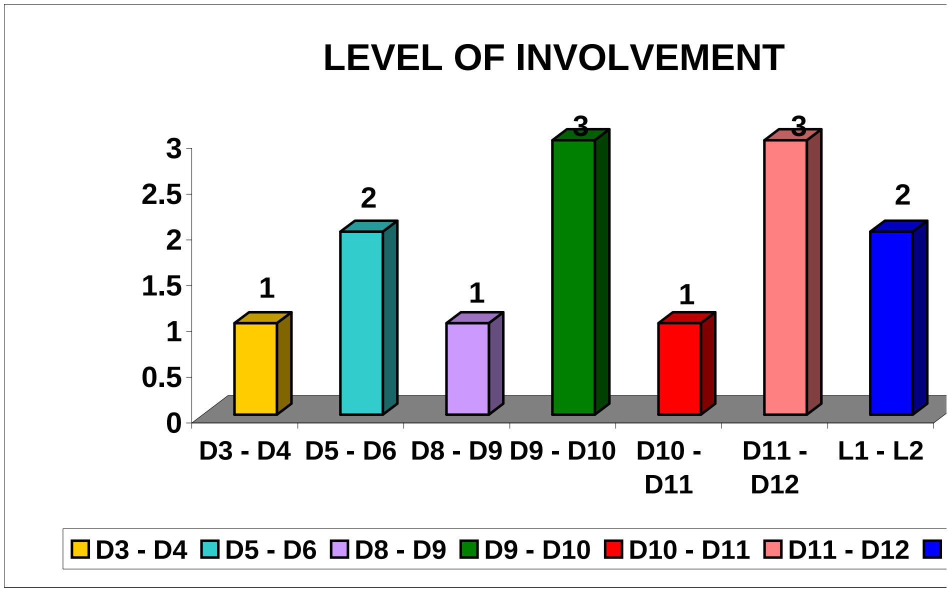
Level	*Number*	*Pre Op*	*Post Op*	*Follow up*
Dorsal	8	25.75	13.75	15.38
Dorso-Lumbar	3	23.67	12.67	20
Lumbar				

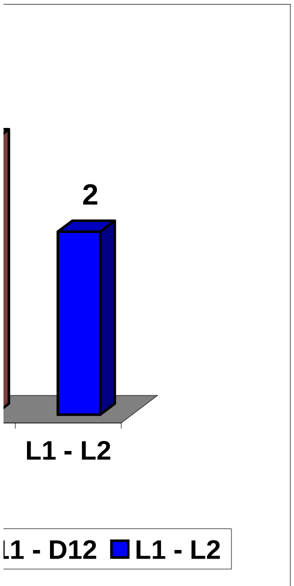


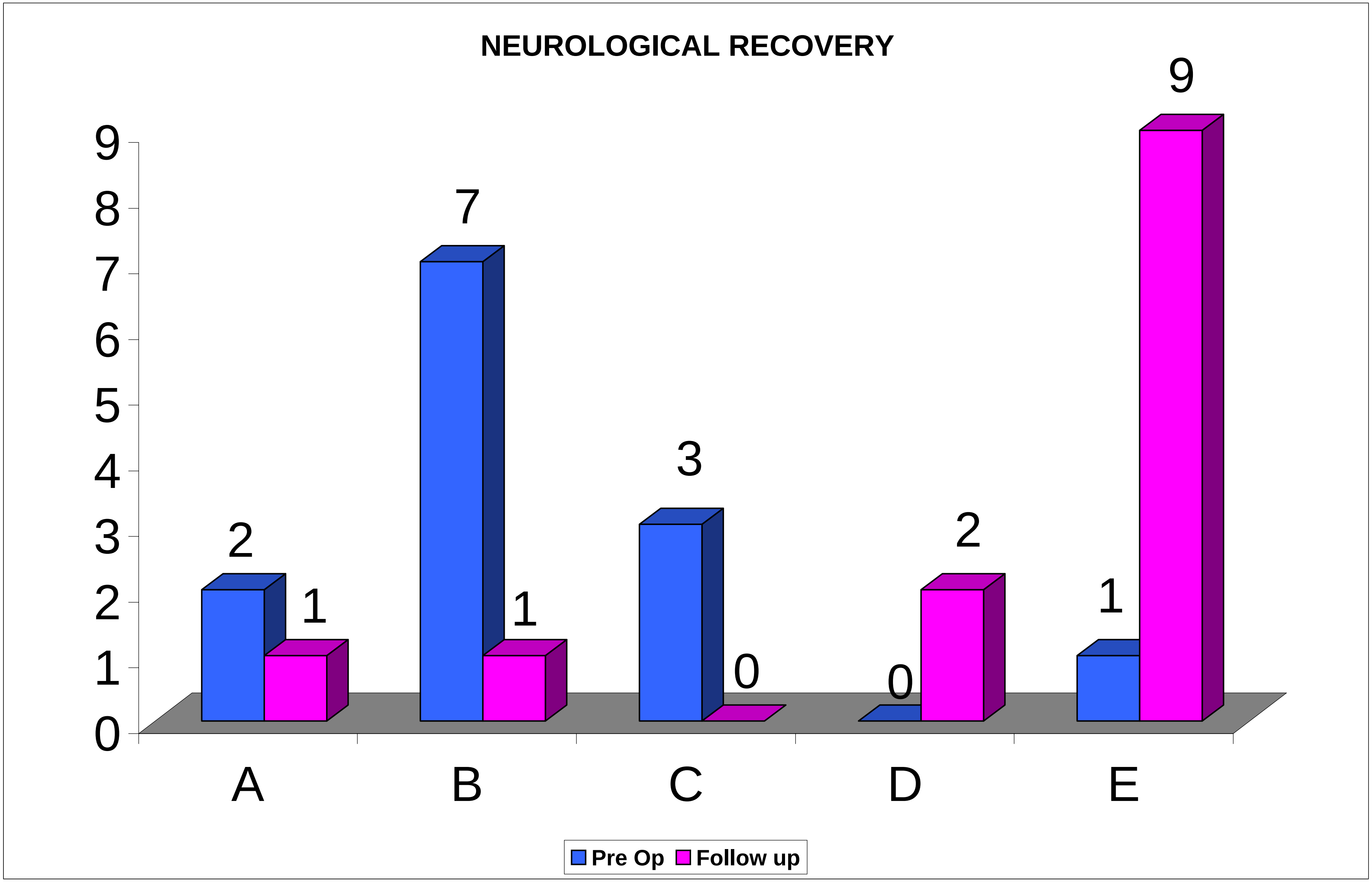

SURGICAL APPROACH
Retro Peritoneal 15%
Right Thoracotomy 23%
Extra Pleural 23%
Left sided thoracotomy 39%
Right Thoracotomy
Left sided thoracotomy
Extra Pleural
Retro Peritoneal


SEX RATIO
Male
46%
Female
54%
Male
Female

D_3 - D_4	1
D_5 - D_6	2
D_8 - D_9	1
D_9 - D_{10}	3
D_{10} - D_{11}	1
D_{11} - D_{12}	3
L_1 - L_2	2




2
L1 - L2
L1 - D12
L1 - L2



NEUROLOGICAL RECOVERY
9
8
7
6
5
4
3
2
1
0
2
1
7
1
3
0
0
2
1
9
A
B
C
D
E
Pre Op
Follow up

Level	*Number*
Dorsal	8
Dorso lumbar	3
Lumbar	2